

Topic: Modeling and Resilience

Assessing and Promoting Functional Resilience in Flight Crews During Exploration Missions

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The NASA Human Research Program works to mitigate risks to health and performance on extended missions. However, research should be directed not only to mitigating known risks, but also to providing crews with tools to assess and enhance resilience, as a group and individually. We can draw on ideas from complexity theory to assess resilience. The entire crew or the individual crewmember can be viewed as a complex system composed of subsystems; the interactions between subsystems are of crucial importance. Understanding the interactions can provide important information even in the absence of complete information on the component subsystems.

Enabled by advances in noninvasive measurement of physiological and behavioral parameters, subsystem monitoring can be implemented within a mission and during training to establish baselines. Coupled with mathematical modeling, this can provide assessment of health and function. Since the web of physiological systems (and crewmembers) can be interpreted as a network in mathematical terms, we can draw on recent work that relates the structure of such networks to their resilience (ability to self-organize in the face of perturbation). Some of the many parameters and interactions to choose from include: sleep cycles, coordination of work and meal times, cardio-respiratory rhythms, circadian rhythms and body temperature, stress markers and cognition, sleep and performance, immune function and nutritional status. Tools for resilience are then the means to measure and analyze these parameters, incorporate them into models of normal variability and interconnectedness, and recognize when parameters or their couplings are outside of normal limits.